This user’s guide describes the characteristics, operation, and use of the TPS720xxEVM-307 evaluation module (EVM). This EVM demonstrates the Texas Instruments TPS720xx tiny low dropout (LDO) linear regulator in a 5-pin WCSP package. The TPS720xx supplies up to 350 mA of output current at a fixed output voltage from a 1.1 V to 4.5 V input source. This user’s guide includes setup instructions, test results, schematic diagram, bill of materials (BOM), and PCB layout drawings for the EVM.

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1 Introduction

The TPS720xxEVM-307 evaluation module (EVM) assists designers in evaluating the operation and performance of the TPS720xx low dropout (LDO) linear regulator. This LDO provides up to 350 mA of output current at a fixed output programmed at the factory. The board features the 1.33-mm × 0.96-mm 5-pin WCSP package for a tiny solution size.

1.1 Related Documentation From Texas Instruments

TPS720xx, 350 mA Low Dropout Linear Regulator with Bias Pin in a 5-Pin WCSP Package data sheet (SBVS100)

1.2 Performance Specification Summary

Table 1 provides a summary of the TPS720xxEVM-307 performance specifications. All specifications are given for an ambient temperature of 25°C.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>VOLTAGE RANGE (V)</th>
<th>CURRENT RANGE (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MIN</td>
<td>TYP</td>
</tr>
<tr>
<td>V_{BIAS} supply</td>
<td>TPS72013EVM-307 (HPA307-001)</td>
<td>2.7(1)</td>
</tr>
<tr>
<td></td>
<td>TPS72015EVM-307 (HPA307-002)</td>
<td>2.9(1)</td>
</tr>
<tr>
<td>V_{IN} supply</td>
<td>TPS72013EVM-307 (HPA307-001)</td>
<td>1.5(1)</td>
</tr>
<tr>
<td></td>
<td>TPS72015EVM-307 (HPA307-002)</td>
<td>1.7(1)</td>
</tr>
<tr>
<td>V_{OUT}</td>
<td>TPS72013EVM-307 (HPA307-001)</td>
<td>1.274</td>
</tr>
<tr>
<td></td>
<td>TPS72015EVM-307 (HPA307-002)</td>
<td>1.47</td>
</tr>
</tbody>
</table>

(1) This is the minimum voltage to provide the maximum output current in the table assuming the typical V_{BIAS} voltage is applied. Lower output currents are achievable with lower V_{IN} and V_{BIAS} voltages. See the data sheet for V_{IN} to V_{OUT} and V_{BIAS} to V_{OUT} dropout data.

(2) Linear regulator power dissipation is computed as P = (V_{IN} − V_{OUT}) × I_{OUT}. As specified in the data sheet, the regulator's package has a finite power dissipation rating depending on the ambient temperature, board type, and airflow. Using V_{IN} and/or V_{OUT} voltages other than the typical voltages recommended in the table or using the EVM in an environment with an ambient temperature higher than 25°C significantly reduces the maximum allowed output current. See the data sheet for the regulator package's thermal resistance data, and see TI application report Digital Designer's Guide to Linear Voltage Regulators and Thermal Management (SLVA118) for a full explanation.

(3) The maximum allowable voltage on V_{IN} is the lesser of 4.5V or the voltage on V_{BIAS}, as specified in the datasheet.

1.3 Modifications

To aid user customization of the EVM, the board was designed with devices having 0603 or larger footprints. A real implementation likely occupies less total board space.

Changing components can improve or degrade EVM performance. For example, adding a larger output capacitor reduces output voltage undershoot but lengthens response time after a load transient event. Adding a larger input capacitor reduces droop at the V_{IN} pin that inductive leads from the V_{IN} power supply may cause during a load transient.
2 EVM Jumpers and Connectors

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TPS720xxEVM-307.

Table 2. TPS720xxEVM-307 Jumpers and Connectors

<table>
<thead>
<tr>
<th>JUMPER</th>
<th>DESCRIPTION</th>
<th>DIRECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1 - pin 1</td>
<td>Input Bias Voltage Connection</td>
<td>Connect the lead from the power terminal of the bias input source to this input. The supply must be between 2.5 V and 5.5 V. The supply must also be at least 1.4 V above the output voltage.</td>
</tr>
<tr>
<td>J1 - pin 2</td>
<td>Input Bias Ground Connection</td>
<td>Connect the lead from the return terminal of the bias source to this input.</td>
</tr>
<tr>
<td>J2</td>
<td>Input V_IN Connection</td>
<td>Connect the lead from the power terminal of the input source to this input. The supply must be between 1.1 V and 4.5 V. The supply must be greater than 200 mV plus the output voltage.</td>
</tr>
<tr>
<td>J3</td>
<td>Input Ground Connection</td>
<td>Connect the lead from the return terminal of the input source to this input.</td>
</tr>
<tr>
<td>J4</td>
<td>Output V_OUT Connection</td>
<td>Connect the positive side of the load and/or output multimeter to this output.</td>
</tr>
<tr>
<td>J5</td>
<td>Output Ground Connection</td>
<td>Connect the lead from the return terminal of the load and/or output multimeter to this output.</td>
</tr>
<tr>
<td>JP1</td>
<td>V_IN and V_BIAS Connection</td>
<td>This jumper allows the user to use one supply to power the TPS720xxEVM-307. Place a shunt across the pins of JP1 to connect the V_IN and V_BIAS inputs. The J1 or the J2 connector may be used to supply the circuit with the shunt installed. In this mode, the supply must meet the requirements for both the V_IN and V_BIAS supplies. Remove the shunt to use separate supplies for each input.</td>
</tr>
<tr>
<td>JP2</td>
<td>EN</td>
<td>Enable input for the TPS720xxEVM-307. Place a shunt across the ON and EN pins of JP2 to disable the TPS720xxEVM-307. A shunt must be installed on JP2 in either ON or OFF positions and EN should not be left unconnected.</td>
</tr>
</tbody>
</table>

3 Operation

Connect the positive input of the bias supply to the V_BIAS pin on J1 (pin 1). Connect the positive input power supply to the V_IN pins on J2. Connect the input bias supply return (ground) to pin 2 of J1. Connect the input power return (ground) for V_IN to the GND pin on J3. The TPS720xxEVM-307 has a maximum input voltage of 5V for V_IN and 6V for V_BIAS. The recommended maximum operating input voltage is 4.5 V for V_IN and 5.5V for V_BIAS.

Connect the desired load between V_OUT (J4) and GND (J5). The TPS720xx supplies up to 350 mA of output current.

Configure jumpers JP1 and JP2 as described in the TPS720xxEVM-307 Jumpers and Connectors table.
4 Test Results

This section provides typical performance waveforms using the TPS720xxEVM-307 printed circuit board.

Figure 1. Startup From Enable of the TPS72015EVM-307 into 350 mA Load (V<sub>IN</sub> = 2V, V<sub>Bias</sub> = 2.9V)

Figure 2. Load Transient of the TPS72015EVM-307, V<sub>IN</sub> = 2V, V<sub>Bias</sub> = 2.9V, I<sub>Out</sub> = 0mA to 300mA to 0mA
5 Board Layout, Schematic and Bill of Materials

This section provides the TPS720xxEVM-307 board layout, schematic and bill of materials.

5.1 Board Layout

Board layout is important for all LDO power supplies. If the layout is not carefully done, the regulator could show stability problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input and output capacitor should be placed as close as possible to the IC. Figure 3 through Figure 5 show the board layout for the TPS720xxEVM-307 PCB.

![Board Layout Diagram](image-url)
Figure 6. TPS720xxEVM-307 Schematic

TPS720xxEVM-307 Schematic and Bill of Materials

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5.2 Schematic and Bill of Materials

TPS720xxEVM-307

- VBIAS 2.5V to 5.5V
- GND
- J1
- J2
- VIN (4.5V max)
- C1 Open
- C2 1.0µF
- R1 0
- JP1
- TP1
- C3 0.1µF
- TP2
- C4 2.2µF
- C5 Open
- J4
- J5
- GND
- U1 TPS720xxYZU
- A1 IN
- A2 OUT
- A3
- C3
- B2
- C1
- YZU Package

⚠️ Open
⚠️ See BOM for part number.
⚠️ Dependent upon package power dissipation and ambient temperature

TPS720xxEVM-307

Board Layout, Schematic and Bill of Materials
<table>
<thead>
<tr>
<th>COUNT</th>
<th>RefDes</th>
<th>Value</th>
<th>Description</th>
<th>SIZE</th>
<th>Part Number</th>
<th>MFR</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>C1</td>
<td>Open</td>
<td>Open</td>
<td>0805</td>
<td>Std</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>C2</td>
<td>1.0uF</td>
<td>Capacitor, Ceramic, 10V, X5R, 20%</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>C3</td>
<td>0.1uF</td>
<td>Capacitor, Ceramic, 6.3V, X5R, 20%</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>C4</td>
<td>2.2uF</td>
<td>Capacitor, Ceramic, 6.3V, X5R, 10%</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>C5</td>
<td>Open</td>
<td>Capacitor, Ceramic, 6.3V, X5R, 10%</td>
<td>Std</td>
<td>Std</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>R1</td>
<td>0</td>
<td>Resistor, Chip, 5%</td>
<td>0603</td>
<td>Std</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>J1-J5</td>
<td>PTC36SAAN</td>
<td>Header, Male 2-pin, 100mil spacing, (36-pin strip)</td>
<td>Std</td>
<td></td>
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<tr>
<td>1</td>
<td>1</td>
<td>JP1</td>
<td>PTC36SAAN</td>
<td>Header, 2-pin, 100mil spacing, (36-pin strip)</td>
<td>Std</td>
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<tr>
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<td>JP2</td>
<td>PTC36SAAN</td>
<td>Header, 3-pin, 100mil spacing, (36-pin strip)</td>
<td>Std</td>
<td></td>
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<tr>
<td>2</td>
<td>2</td>
<td>TP1, TP2</td>
<td>5000</td>
<td>Test Point, Red, Thru Hole Color Keyed</td>
<td>5000</td>
<td></td>
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<tr>
<td>1</td>
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<td>U1</td>
<td>TPS72013YZU IC, LDO Linear Regulator With Bias Pin, 350mA</td>
<td>WCSP-5</td>
<td>TPS72013YZU</td>
<td>TI</td>
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<td>0</td>
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<td>WCSP-5</td>
<td>TPS72015YZU</td>
<td>TI</td>
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</tr>
<tr>
<td>2</td>
<td>2</td>
<td>–</td>
<td>Shunt, 100mil, Black</td>
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<td>929950-00</td>
<td>3M</td>
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<td>1</td>
<td>1</td>
<td>–</td>
<td>HPA307 Rev. A PCB</td>
<td>0.062&quot;x1.025&quot;x1.45&quot;</td>
<td>HPA307</td>
<td>Any</td>
</tr>
</tbody>
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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 1.1 V to 4.5 V on Vin and 2.5 V to 5.5V on Vbias and the output voltage range of 0.9 V to 3.6 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

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During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 85°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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